Remembering E. O. Lawrence

"For those who had the good fortune to be close to him both personally and scientifically, he will always seem a giant among men."—Luis Alvarez

SCIENCE was his adventure. In a Golden Age of particle physics, Ernest Orlando Lawrence embarked on the adventure and ended up creating the model for large-scale science, winning a Nobel Prize, and infecting succeeding generations of scientists with his enthusiasm and drive.

Born a century ago on August 8, 1901, in Canton, South Dakota, Lawrence manifested his scientific spirit early. As a youngster, he didn't stop at building model gliders. Instead, he constructed an early version of a shortwave radio transmitting station. This shortwave experience was a harbinger of his future work when, in 1931, Lawrence became the first person to accelerate particles to high energies using shortwave radio techniques.

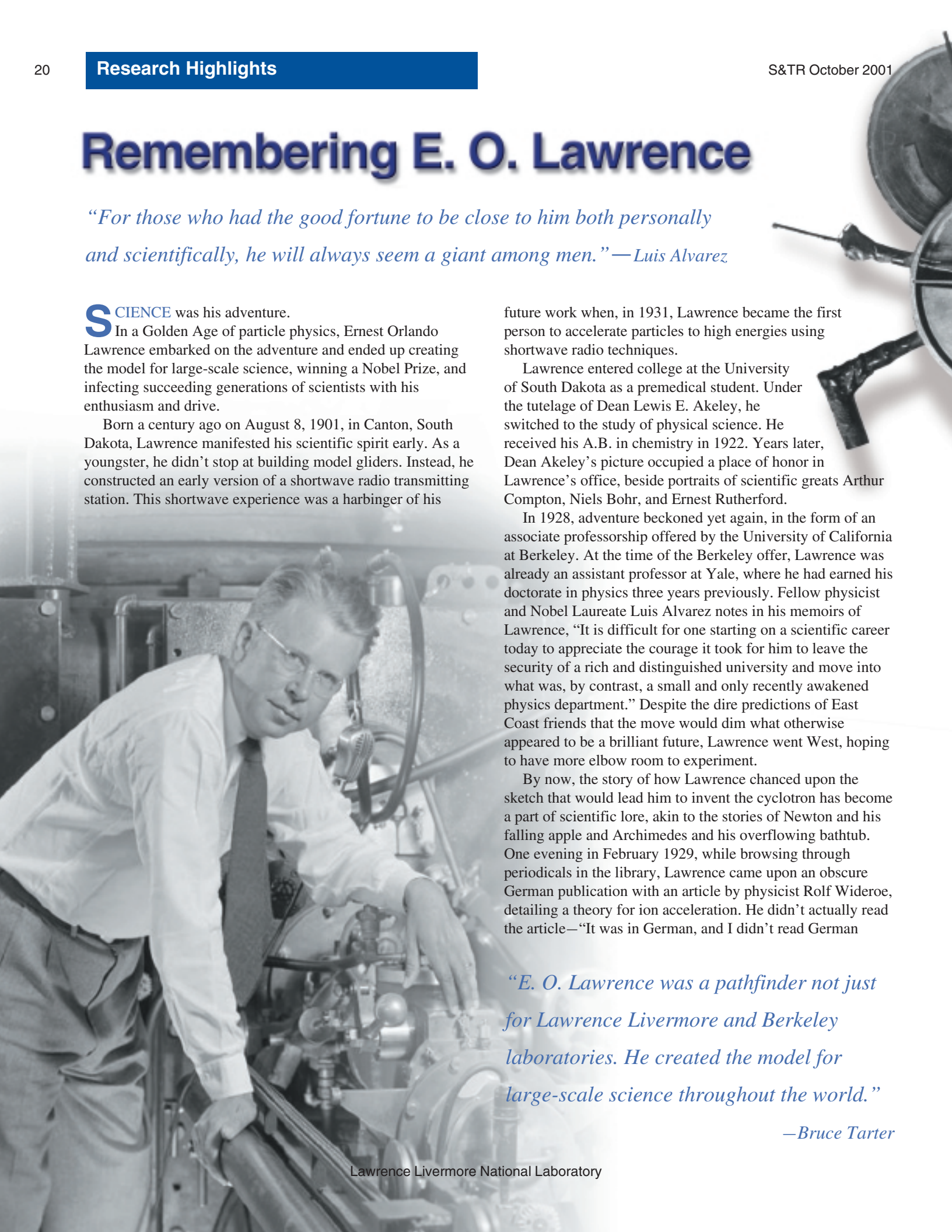
Lawrence entered college at the University of South Dakota as a premedical student. Under the tutelage of Dean Lewis E. Akeley, he switched to the study of physical science. He received his A.B. in chemistry in 1922. Years later, Dean Akeley's picture occupied a place of honor in Lawrence's office, beside portraits of scientific greats Arthur Compton, Niels Bohr, and Ernest Rutherford.

In 1928, adventure beckoned yet again, in the form of an associate professorship offered by the University of California at Berkeley. At the time of the Berkeley offer, Lawrence was already an assistant professor at Yale, where he had earned his doctorate in physics three years previously. Fellow physicist and Nobel Laureate Luis Alvarez notes in his memoirs of Lawrence, "It is difficult for one starting on a scientific career today to appreciate the courage it took for him to leave the security of a rich and distinguished university and move into what was, by contrast, a small and only recently awakened physics department." Despite the dire predictions of East Coast friends that the move would dim what otherwise appeared to be a brilliant future, Lawrence went West, hoping to have more elbow room to experiment.

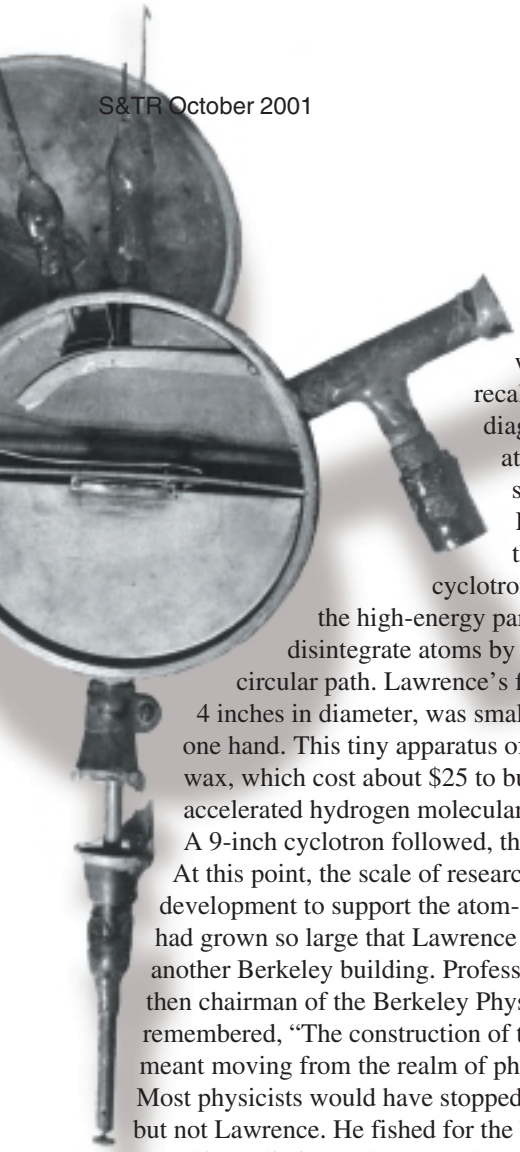
By now, the story of how Lawrence chanced upon the sketch that would lead him to invent the cyclotron has become a part of scientific lore, akin to the stories of Newton and his falling apple and Archimedes and his overflowing bathtub. One evening in February 1929, while browsing through periodicals in the library, Lawrence came upon an obscure German publication with an article by physicist Rolf Wideroe, detailing a theory for ion acceleration. He didn't actually read the article—"It was in German, and I didn't read German

"E. O. Lawrence was a pathfinder not just for Lawrence Livermore and Berkeley laboratories. He created the model for large-scale science throughout the world."

—Bruce Tarter



Lawrence Livermore National Laboratory



well," Lawrence recalled—but one of the diagrams drew his attention. From that single diagram, Lawrence sketched out the core design of a cyclotron—a way of producing the high-energy particles needed to disintegrate atoms by "pushing" them in a circular path. Lawrence's first cyclotron, all of 4 inches in diameter, was small enough to hold in one hand. This tiny apparatus of brass and sealing wax, which cost about $25 to build, successfully accelerated hydrogen molecular ions to 80,000 volts. A 9-inch cyclotron followed, then an 11-inch one. At this point, the scale of research and the engineering development to support the atom-smashing projects had grown so large that Lawrence had to be moved into another Berkeley building. Professor Raymond Birge, then chairman of the Berkeley Physics Department, remembered, "The construction of the larger [cyclotrons] meant moving from the realm of physics into engineering. Most physicists would have stopped with what they know, but not Lawrence. He fished for the big ones."

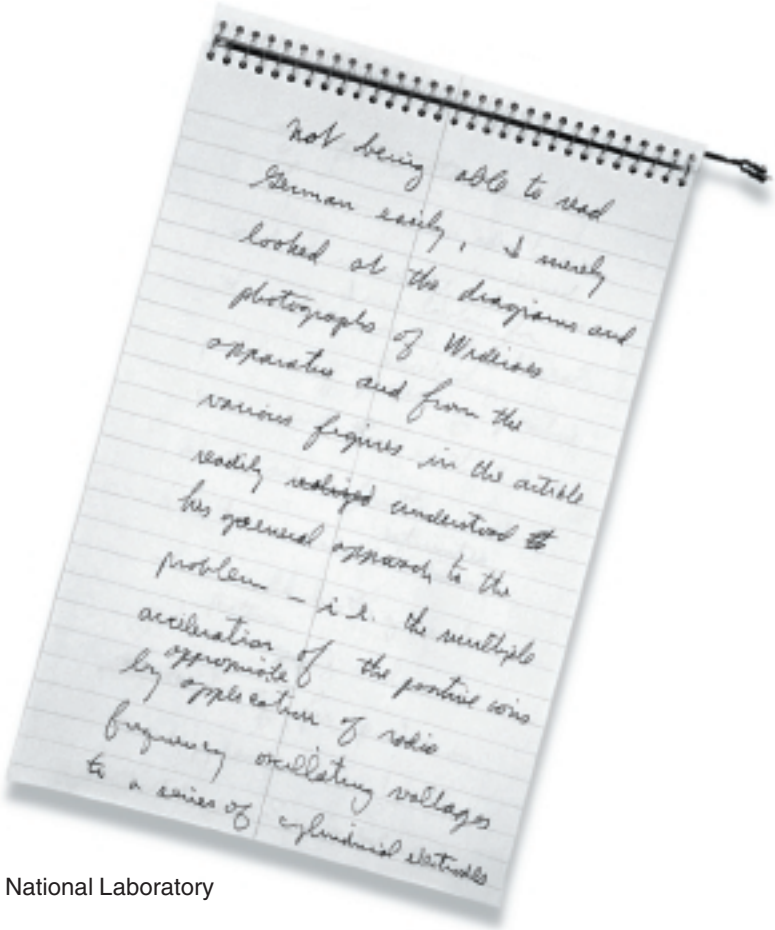
In his Radiation Laboratory (known as the Rad Lab), Lawrence integrated both theoretical scientists and engineers into his projects, and the laboratory became the prototype of the big laboratories that would follow. By 1939, the Rad Lab featured a 37-inch cyclotron that, in addition to being used for exploring nuclear physics, was also being used in a radical new treatment for cancer. Lawrence was quick to see the possibilities of the cyclotron beyond pure physics. He worked alongside medical doctors, chemists, biologists, and engineers to create uses for the product radioisotopes.

On November 10, 1939, Lawrence was awarded the Nobel Prize in physics. At the time of the announcement, World War II had just broken out in Europe, and Lawrence began focusing his efforts—as so many other prominent scientists did at the time—on the war effort. Lawrence helped establish the radar program at the Massachusetts Institute of Technology and the sonar development program for antisubmarine warfare in San Diego in 1941. Back at the Radiation Laboratory, he converted the 37-inch cyclotron into a mass spectrometer, using it to successfully separate small amounts of uranium-235 from natural uranium. Lawrence's work—along with that of J. Robert Oppenheimer—greatly contributed to creating the atomic bomb. In early 1945, mere months before the first bomb was dropped, Lawrence said, "The atomic bombs will surely shorten the war, and let us hope that they will effectively end war as a possibility in human affairs."

After the war, Lawrence focused on basic scientific research at the Rad Lab until 1949, when the Soviet Union exploded its first nuclear device. Lawrence again turned his attention to national security issues. At the time, there was already a debate within government, military, and scientific

"Scientific achievement is rooted in the past, is cultivated by contemporaries, and flourishes only in a favorable environment. No individual is alone responsible for a single stepping stone along the path of progress."

—Ernest O. Lawrence



circles over the need for a second weapons laboratory. Physicist Edward Teller, who had made key contributions to the development of thermonuclear weapons while at Los Alamos, was foremost among those pressing for such a facility. Teller's rationale was twofold: the Los Alamos thermonuclear program was not proceeding at a fast enough pace, and a second laboratory would provide a source of mutual competition.

In 1951, Thomas Murray, a member of the Atomic Energy Commission (or AEC, the forerunner to the present Department of Energy) contacted Lawrence to discuss the issue of a second laboratory. Lawrence responded favorably and asked Herbert York, who at the time was one of his postdoctoral students, to survey the science community on the need for a second nuclear weapons research laboratory. Convinced that such a laboratory was needed, Lawrence then urged the AEC and the Joint Congressional Committee on Atomic Energy to set up a second weapons laboratory. He offered the Rad Lab's satellite site in the Livermore Valley as a possible location as well as his personal oversight of this new project. Livermore Laboratory was established in 1952 as a branch of the University of California Radiation Laboratory. Herbert York was its first director, overseeing daily operations at the site. Teller also remained in Livermore, working with Livermore scientists to build the nuclear program. Lawrence split his time and effort between Berkeley and Livermore. York recalls that Lawrence "always wanted to hear what was going on. We would spend one or two hours just walking around the Laboratory, visiting every place. The shops, the chemistry laboratories, the drafting rooms—there was no place he didn't want to go and where he wouldn't just stop and talk with anybody and ask, 'What are you doing right now?' and expect an answer."

Even with two laboratories to run, Lawrence found time for his family: his wife Molly and their six children. Robert Lawrence, one of his sons, recalled that his father was an inveterate tinkerer: "He built us all sorts of things growing up—scooters, wagons, other toys. … He asked us one day what he should build next, and we all said 'Build a color TV!' And so he would play with the tube on weekends, and he came up with a better, cheaper TV tube than the ones on the market. And he did it for fun, on the weekend."

Lawrence died on August 27, 1958. By the time of his death, at age 57, he had won virtually every major award in his field, ushered in a new age of physics, and developed a new way of doing science. Soon after his death, the University of California regents renamed the Berkeley and Livermore laboratories to honor him. In discussing Lawrence and the evolution of his laboratories, Herb York concluded, "I think if Lawrence were to visit the Lab today, he'd take the same 'gee whiz' attitude that he took 50 years ago. His lab has evolved in a perfectly natural way—the scope is wider, but the science is still an adventure."

—Ann Parker

As physicist Luis Alvarez notes, "One of the greatest difficulties one encounters in writing of Ernest Lawrence's career is that so much must be omitted in order to keep the account within reasonable bounds."

For more information about Ernest O. Lawrence, his life and times, see the following:
www.llnl.gov/llnl/history/eolawrence.html
www.lbl.gov/Publications/Currents/Archive/Aug-10-2001-EOL/TheMan.html
www.nobel.se/physics/laureates/1939/lawrence-bio.html
www.lbl.gov/Science-Articles/Research-Review/Magazine/1981/

"Life to him seemed to be one thrill after another, but he was also always persistent and insistent!"

—Gunda Lawrence

Lawrence Livermore National Laboratory